King County Marine Ambient Monitoring Program

2011 Subtidal Sediment Sampling Event

Final Sampling and Analysis Plan

Prepared for the

King County Department of Natural Resources and Parks
Water and Land Resources Division – Environmental Laboratory

by the

King County Department of Natural Resources and Parks
Marine and Sediment Assessment Group

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1 INTRODUCTION

This sampling and analysis plan (SAP) presents project information and sampling and analytical methodologies that will be employed to perform subtidal sediment sampling in 2011 for King County's marine ambient monitoring program. This work is being performed as part of a long-term sediment monitoring program designed to assess sediment quality in Elliott Bay, the Central Basin of Puget Sound proximal to King County, and three smaller embayments. The SAP includes a description of the project, sampling and analytical methodologies, and reporting requirements. All figures referenced in the SAP may be found at the end of the narrative. This SAP has been prepared in accordance with Washington State Department of Ecology (Ecology) sampling and analysis plan preparation guidance (Ecology 2008) as well as Chapter 173-204 WAC, the Washington State Sediment Management Standards (Ecology 1995).

2 PROGRAM DIRECTIVES

King County's marine ambient monitoring program gathers water, sediment, and biota data in the Central Basin of Puget Sound, including Elliott Bay and the Duwamish River. These data are used to provide an understanding of water and sediment quality issues – both to assess the general health of the Puget Sound marine environment within King County and as a comparative aid to confirm that discharges from the County's wastewater outfalls are not adversely affecting the marine environment. The marine ambient monitoring program is also part of an intergovernmental effort, the Puget Sound Assessment and Monitoring Program (PSAMP), that monitors the health of the Puget Sound marine environment on a larger-scale, region-wide basis.

3 MONITORING HISTORY

King County has collected sediment quality data from subtidal ambient monitoring stations for many years; formerly on an annual basis and biennially between 1996 and 2004. These subtidal monitoring stations were located within Elliott Bay and in the Central Basin, proximal to the City of Seattle. Sampling locations were traditionally located to monitor sediment quality in areas within the general vicinity but away from the direct impact of potential point-source pollution such as wastewater and storm water outfalls and general non-point sources such as the Duwamish River.

Samples were collected from the top two centimeters (cm) of sediment and analyzed for metals and organic chemicals in order to evaluate sediment quality in the most-recently deposited material. Sediment quality has been evaluated by comparing metals and organics concentrations to the published sediment quality chemical criteria of the Washington State Sediment Management Standards (SMS) as well as Puget Sound region-wide sediment data.

The former subtidal sediment monitoring program was temporarily discontinued after 2004 to provide an opportunity for King County staff scientists and a peer review panel to evaluate data generated from the program as well as other data collection efforts within the region. Following this review, King County expanded its marine ambient subtidal sediment monitoring program in 2007 to focus on sediment quality in Elliott Bay, while still monitoring truly ambient sediment quality in the Central Basin, including three smaller embayments of interest. The Elliott Bay sediment monitoring program includes eight stations with sampling occurring every two years. The other six stations will be sampled every five years. The 14 stations that were sampled initially in 2007 are shown in Table 3-1.

Table 3-1
Marine Ambient Subtidal Sediment Monitoring Stations

Station	Description	Schedule	Rationale
KSBP01	Central Basin – Point Jefferson	Every 5 Years	North Central Basin water quality station.
LSML01	Central Basin – West Seattle	Every 5 Years	Long-term sediment monitoring station.
NSEX01	Central Basin – East Passage	Every 5 Years	South Central Basin water quality station.
KSRU03	Outer Salmon Bay	Every 5 Years	Potential impact from locks/vessel traffic.
LSVV01	Fauntleroy Cove	Every 5 Years	History of water quality issues/ferry traffic.
MSVK01	Inner Quartermaster Harbor	Every 5 Years	Important habitat area/high recreational use.
KSZY01	Elliott Bay - Piers 90/91	Every 2 Years	Location of large vessel traffic/docking.
LTAA02	Elliott Bay - Grain Terminal	Every 2 Years	Location of large vessel traffic/docking.
LSCW02	Elliott Bay - Outer	Every 2 Years	Long-term sediment monitoring station.
LTCA02	Elliott Bay - North Central	Every 2 Years	Long-term sediment monitoring station.
LTDF01	Elliott Bay - Waterfront	Every 2 Years	Long-term sediment monitoring station.
LTED04	Elliott Bay - South Central	Every 2 Years	Long-term sediment monitoring station.
LSHZ08	Elliott Bay - Cove 2	Every 2 Years	High recreational use/sediment contact.
LTGF01	Elliott Bay - Harbor Island	Every 2 Years	Location of heavy industry/shipbuilding.

The eight Elliott Bay stations were sampled for the second time in June 2009. The 2011 marine ambient subtidal sediment sampling event will again focus on the eight stations located in Elliott Bay. The remaining six stations will be sampled next in 2012.

4 SAMPLING DESIGN

The primary goal of the marine ambient sediment monitoring program is to collect data of known quality in order to effectively characterize marine sediments within King County. The eight stations located in Elliott Bay began a biennial sampling regime in 2007, which was repeated in 2009. This sampling frequency will allow King County and other decision-makers to better evaluate temporal changes in sediment quality and help assess the potential positive impacts to the marine environment from various sediment cleanup projects and other riparian improvements in Elliott Bay. Four of the Elliott Bay stations have long-term sediment quality data sets that will continue with King County's redesigned sediment sampling program. These stations are:

- LSCW02 – located at the hypothetical boundary-line between Elliott Bay and the Central Basin of Puget Sound;
- LTCA02 – located in the center of Elliott Bay;
- LTED04 – located in the center of Elliott Bay, inshore of LTCA02; and
- LTDF01 – located along the central Seattle waterfront, near Pier 66.

These four stations form a rough east-west transect away from locations of potential point-source impacts to the sediment. The four other Elliott Bay stations added to the monitoring program in 2007 will assess specific areas of the bay. These stations are:

- KSZY01 – located just offshore of Piers 90/91. This area has historically received high heavy-vessel traffic and will continue to receive large ships when cruise liners begin using these docking facilities.
- LTAA02 – located just offshore of the grain terminal. This area has also historically received high heavy-vessel traffic and docking.
- LTGF01 – located just offshore of the northern end of Harbor Island. This location is in an area of heavy industry, including fuel storage and transfer, shipbuilding and repair, and the transportation industry.
- LSHZ08 – located just offshore of Cove 2 at Seacrest Park. This area has high usage by recreational SCUBA divers, including diving classes, which provides a high incidence of primary contact with bottom sediments, especially by student divers.

4.1 Data Quality Objectives

The data quality objectives (DQOs) of the 2011 subtidal sediment sampling event are to collect data of sufficient *quantity* and *quality* to be able to meet the following study goals:

- evaluate the areal extent and spatial variations of sediment chemical concentrations in Elliott Bay;
- compare sediment chemical concentrations to Puget Sound-wide regional values; and
- evaluate sediment chemical concentrations relative to the current marine sediment quality standards of Chapter 173-204 WAC (Ecology 1995).

The *quantity* of sediment chemistry data to be collected is based on previous sampling events conducted under King County's marine ambient monitoring program as well as Ecology's marine sediment monitoring program, conducted in association with PSAMP. Four of the sampling stations in this monitoring event were sampled biennially between 1996 and 2004

and last sampled in 2009. The other four stations were first sampled in 2007 and again in 2009. One sediment sample will be collected from each of eight stations. The spatial distribution of King County's eight sediment monitoring stations in Elliott Bay complements Ecology's stations for their Urban Waters Initiative monitoring program, which also began sampling Elliott Bay in 2007. The biennial frequency of King County's sediment monitoring program in Elliott Bay will supplement the data collected under the Urban Waters Initiative, which monitors Elliott Bay once every five years.

Validation of project data will assess whether the data collected are of sufficient *quality* to meet the study goals. The data quality issues of precision, accuracy, bias, representativeness, completeness, comparability, and sensitivity are described in the following sections.

4.1.1 Precision, Accuracy, and Bias

Precision is the agreement of a set of results among themselves and is a measure of the ability to reproduce a result. Accuracy is an estimate of the difference between the true value and the determined mean value. The accuracy of a result is affected by both systematic and random errors. Bias is a measure of the difference, due to a systematic factor, between an analytical result and the true value of an analyte. Precision, accuracy, and bias for sediment chemistry will be measured by the following quality control (QC) analyses: method blanks, spike blanks, matrix spikes, matrix spike duplicates, certified reference materials, laboratory control samples, and laboratory duplicates or triplicates.

4.1.2 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at the sampling point, or an environmental condition. Sediment chemistry samples will be collected from stations with pre-selected coordinates to represent specific site locations. Sediment chemistry samples will be homogenized to minimize variations in the chemical and physical composition of the sediments. Following the guidelines described for sampler decontamination, sample acceptability criteria, and sample processing (Section 6) will also help ensure that samples are representative.

4.1.3 Completeness

Completeness is defined as the total number of samples for which acceptable analytical data are generated, compared to the total number of samples submitted for analysis. Adhering to standardized sampling and testing protocols will aid in providing a complete set of data for this study. The goal for completeness is 100%. If 100% completeness is not achieved, the study team will evaluate whether the DQOs can still be achieved or if additional samples may need to be collected and analyzed.

4.1.4 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared to another. This goal is achieved through using standard techniques to collect and analyze representative samples, along with standardized data validation and reporting procedures. By following the guidance of this SAP, the goal of comparability will be achieved.

4.1.5 Sensitivity

Sensitivity is a measure of the capability of analytical methods to meet study goals. The sediment chemistry analytical method detection limits presented in Section 9 are sensitive enough to allow comparison of sediment chemistry data to current Ecology sediment quality criteria, both normalized to dry weight and to organic carbon, as appropriate.

4.2 Sampling Strategy

Sediment chemistry samples will be collected from eight stations located in Elliott Bay. Samples will be collected from the top 2 cm of sediment to evaluate chemical concentrations in the most-recently deposited material. All field work will be conducted on board King County's research vessel *Liberty*.

4.2.1 Location of Sampling Stations

Sediment chemistry samples will be collected from the eight stations shown in Figure 1. Coordinates and water depth for these stations are shown in Table 4-1.

Table 4-1
2011 Marine Ambient Subtidal Sediment Monitoring Stations – Coordinates and Water Depths

Station	Description	Northing (NAD83)	Easting (NAD83)	Approx. Depth (ft.)
KSZY01	Elliott Bay - Piers 90/91	231983	1258639	60
LTAA02	Elliott Bay - Grain Terminal	231054	1261260	80
LSCW02	Elliott Bay - Outer	227106	1256271	590
LTCA02	Elliott Bay - North Central	226303	1260915	430
LTDF01	Elliott Bay - Waterfront	225367	1267270	110
LTED04	Elliott Bay - South Central	223909	1264675	300
LSHZ08	Elliott Bay - Cove 2	218767	1259170	80
LTGF01	Elliott Bay - Harbor Island	218854	1265592	100

4.2.2 Sample Acquisition and Analytical Parameters

Sediment chemistry samples will be collected from the 0- to 2-cm depth stratum to characterize the most recently deposited material. Samples will be composited from sediment recovered from a single deployment of dual, tandem 0.1 m^2 modified van Veen grab samplers. Samples will be composited, homogenized, and split into laboratory containers in the field. Parameters of interest will include trace metals and organic compounds, as well as conventional sediment chemistry and physical properties.

Sediment chemistry analytical parameters were selected primarily based on guidance for conducting sediment characterizations (Ecology 2008) as well as for consistency with Ecology's ambient sediment monitoring program and will allow comparison of analytical results with published sediment quality criteria (Ecology 1995). Other analytical parameters were selected based on previous sediment studies in the vicinity, as well as a desire to begin monitoring emerging chemicals of concern such as nonylphenols and polybrominated biphenyl ethers (PBDEs). Analytical parameters will include:

- conventionals – ammonia, particle size distribution (PSD), total organic carbon (TOC), total solids, and total sulfide;
- metals – aluminum, antimony, arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, silver, tin, and zinc; and

- organics - base/neutral/acid semivolatile compounds (BNAs), butyltins, chlorinated pesticides, PBDEs, polychlorinated biphenyls (PCBs), and total 4-nonylphenol (the complete list of organic parameters is shown in Section 9.3).

4.3 Data Analysis

Chemistry data will be evaluated by comparison to sediment chemical criteria from Tables I and III in the Washington State Sediment Management Standards (SMS) of Chapter 173-204 WAC (Ecology 1995). Data from this sampling event will be compared to results from previous King County monitoring events as well as other sediment studies in Puget Sound.

Sediment data for some organic compounds are generally normalized to organic carbon content for comparison to SMS criteria. Normalization to organic carbon can produce biased results, however, when the organic carbon content of the sample is very low (Ecology 1992). When the organic carbon content of a sample is near 0.1 or 0.2% (1,000 to 2,000 milligrams/kilogram (mg/Kg) dry weight), even background concentrations of certain organic compounds can exceed sediment quality criteria. If the organic carbon content at any particular station is below 0.5% dry weight, then dry weight-normalized results for non-ionizable organic compounds will be compared to the 1998 Marine Dry Sediment Quality Standard (SQS) and Cleanup Screening Level (CSL) from Ecology's Environmental Information Management (EIM) database (http://www.ecy.wa.gov/eim/myEIM.htm).

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5 PROJECT ORGANIZATION AND SCHEDULE

The tasks involved in conducting the 2011 marine ambient subtidal sediment sampling event and the King County personnel who will assume responsibility for those tasks are listed below.

- **Scott Mickelson** King County Marine and Sediment Assessment Group – 206.296.8247 scott.mickelson@kingcounty.gov Project management, study design, preparation of SAP, data validation and analysis, and preparation of final study report.
- **Bob Kruger** King County Environmental Laboratory – 206.684.2323 bob.kruger@kingcounty.gov Coordination of all field sampling activities.
- **Katherine Bourbonais** King County Environmental Laboratory – 206.684.2382 katherine.bourbonais@kingcounty.gov Coordination of all laboratory analytical activities, data validation, and data reporting.
- **Colin Elliott** King County Environmental Laboratory – 206.684.2343 colin.elliott@kingcounty.gov Review of SAP, coordination of laboratory quality control, data validation, and data reporting.

Sampling for the 2011 marine ambient subtidal sediment sampling event is anticipated to require up to three days of field time (weather dependent) and will be completed in June 2011. Analytical results for sediment chemistry will be available by October 2011. Validated chemistry data packages and electronic data files will be ready for release by November 1, 2011.

6 SAMPLING PROCEDURES

All sampling will be performed according to guidelines recommended by the Puget Sound Estuary Program's (PSEP) Puget Sound Protocols (PSEP 1997a and 1998). Sampling will be performed by staff of the King County Environmental Laboratory. Sediment samples will be collected using dual, tandem 0.1 m^2 modified, stainless steel van Veen grab samplers deployed via hydrowire and hydraulic winch from King County's research vessel *Liberty*.

Samples will consist of the top 2 cm of sediment collected, ideally, from the contents of a single deployment of the dual grab samplers. Additional grab deployments may be necessary, dependent upon the substrate, to collect enough sediment to perform all analyses. Sediment samples will be stored on ice in coolers while in the field, then transported to the King County Environmental Laboratory at the end of each sampling day. Established chain of custody (COC) procedures will be followed for this sampling event.

6.1 Station Positioning

Reliable station positioning is crucial to be able to revisit established stations for future sampling events. Inaccuracies in station positioning when conducting sediment grab sampling in deep water can result from the action of currents and wind on the sampling vessel as well as current forces and viscous drag on the sampler and deployment line.

Station positioning for the 2011 ambient subtidal sediment sampling event will employ a combination of a differential global positioning system (DGPS), acoustic transponder beacon, and positioning software to calculate the exact position of the van Veen grab samplers as they contact the seafloor. Use of this enhanced positioning system during previous sampling efforts conducted by King County indicates a precision of $\pm$10 feet around a prescribed sampling location.

For station positioning, the research vessel will employ a Trimble® DGPS. Prior to the sampling event, the prescribed station coordinates will be entered into the shipboard DGPS laptop computer. During the sampling event, the shipboard navigational system will utilize the differential data transmissions from regional Coast Guard base stations to automatically correct its GPS satellite data. The GPS antenna is boom-mounted above the sampler descent line to achieve a more accurate coordinate fix above the sampling point.

To increase sampling accuracy, the DGPS system will be enhanced by the addition and integration of an ultra-short baseline acoustical navigation system that will continuously calculate the three-dimensional position of the submerged grab samplers, relative to that of the surface vessel. An electronic compass will be used to reference all underwater directional data to magnetic north.

Upon contact of the grab samplers with the bottom, the coordinate data representing the actual sediment grab impact point will be electronically recorded in real time. Positioning information will include local time and date that a position is recorded, comments, and coordinate data in both latitude/longitude and NAD 83 State Plane formats.

Sample collection is expected to take place within a 6-meter radius of each station's prescribed position and samples will not be collected if the observed coordinates of the grab

deployment are outside of this limit. If conditions such as a steep slope or rocky substrate preclude sample collection at a particular station, the station may be relocated after consultation with the study coordinator, Scott Mickelson, if relocation will not compromise the project goals. Any station relocation will be documented and reported.

6.2 Sampler Deployment and Retrieval

Two 0.1 m^2 modified, stainless-steel van Veen grab samplers will be deployed in tandem at each sampling station. The grab samplers will be lowered at a controlled speed of approximately three feet per second until they near the bottom, at which time the speed will be decreased to approximately one foot per second to minimize potential bow wake activity and subsequent bottom disturbance.

After the grabs have tripped upon reaching the bottom, they will be raised slowly to allow gentle and complete closure of the sampler jaws to avoid sample disturbance and loss. Once clear of the bottom, the ascent speed will be increased to approximately three feet per second. Care will be taken to ensure that minimal sample disturbance occurs when swinging the grabs on board. Collection of undisturbed sediment requires that the grab samplers:

- create a minimal bow wake when descending;
- form a leak-proof seal upon closure of the jaws;
- are carefully retrieved to prevent excessive sample disturbance; and
- allow easy access to the sediment within the grab.

6.3 Sample Acceptability Criteria

When the grab samplers have been secured on board, the hinged top flaps will be opened and the samples examined for acceptability. Acceptability criteria will include:

- the grabs are not overfilled to the point where there is evidence of sample loss around the access doors;
- overlying water is present, indicating minimal leakage;
- overlying water is not excessively turbid, indicating minimal sample disturbance; and
- a minimum acceptable sample penetration depth of at least 4 cm has been achieved.

Samples collected from the top 2 cm of sediment for sediment chemistry will require a minimum grab penetration depth of 4 cm. Care will be taken to extract sediment from the most undisturbed center portion of each grab without collecting sediment that has touched the sides of the grab. Penetration depth will be determined by measuring the depth of sediment within each grab by sliding a ruler vertically along the inside of the grab's side wall after each successful cast. Penetration depth can also be calculated by measuring the space between the sediment's surface within the grab and the top of the grab, then subtracting this vertical distance from 17 cm, the total inside height of the grab. Overlying water within the grab will be carefully siphoned off of the sediment surface for all acceptable samples.

6.4 Sample Processing

Prior to any subsampling, a sediment aliquot will be collected for analysis of total sulfide. The total sulfide sample aliquot will always be collected from undisturbed sediment in one of the grabs using a stainless-steel spoon, and then placed directly in the appropriate sample container without homogenization. The remaining top 2 cm of undisturbed sediment in both

grabs will be collected with a stainless-steel "cookie cutter" and spatula. This sediment will be placed in a stainless-steel bowl for homogenization, after which aliquots for the remaining analyses will be transferred to appropriate laboratory containers. Prior to homogenization, collected sediment will be stored covered with aluminum foil in coolers in the event that multiple grab deployments are required.

Head space will be left in all lab containers, with the exception of total sulfide, to allow further mixing at the laboratory and for expansion should the containers be stored frozen. All sample containers will be stored in insulated, ice-filled coolers while in the field. Total sulfide samples also require the use of a preservative. After the 4-ounce total sulfide lab container has been filled completely, 5 milliliters (ml) of 2N zinc acetate will be added to the top of the sediment prior to sealing the container. All sample containers, storage conditions, and hold times are summarized in Table 6-1.

Table 6-1
Sediment Chemistry Sample Containers, Storage Conditions, and Analytical Hold Times

Analyte	Container	Preferred Storage Conditions	Hold Time	Acceptable Storage Conditions	Hold Time
Ammonia	4-oz. CWM PP or glass	refrigerate at 4°C	7 days to analyze	N/A	N/A
Particle Size Distribution	16-oz. CWM PP or glass	refrigerate at 4°C	6 months to analyze	N/A	N/A
Total Organic Carbon	4-oz. CWM PP or glass	freeze at -18°C	6 months to analyze	refrigerate at 4°C	14 days to analyze
Total Solids (collect w/ TOC)	4-oz. CWM PP or glass	freeze at -18°C	6 months to analyze	refrigerate at 4°C	14 days to analyze
Total Sulfide	4-oz. CWM PP or glass No Headspace	refrigerate at 4°C w/ 2N Zn acetate	7 days to analyze	N/A	N/A
Mercury	250-ml CWM PP	freeze at -18°C	28 days to analyze	N/A	N/A
Other Metals	250-ml CWM PP	freeze at -18°C	2 years to analyze	refrigerate at 4°C	6 months to analyze
BNAs	16-oz. glass	freeze at -18°C	1 year to extract 40 days to analyze	refrigerate at 4°C	14 days to extract 40 days to analyze
Butyltins	8-oz. glass	freeze at -18°C	1 year to extract 40 days to analyze	refrigerate at 4°C	14 days to extract 40 days to analyze
Pesticides/PCBs (collect w/ BNAs)	16-oz. glass	freeze at -18°C	1 year to extract 40 days to analyze	refrigerate at 4°C	14 days to extract 40 days to analyze
PBDEs (collect w/ BNAs)	16-oz. glass	freeze at -18°C	1 year to extract 40 days to analyze	refrigerate at 4°C	14 days to extract 40 days to analyze

CWM PP – Clear, wide-mouth polypropylene

6.5 Sampling Equipment Decontamination

The grab samplers will be decontaminated between sampling stations by scrubbing with a brush and ambient sea water, followed by a thorough *in situ* rinsing. A separate stainless steel bowl, cookie cutter, spatula, and spoon will be dedicated to each sampling station, precluding the need for decontamination of this equipment.

6.6 Sample Storage and Delivery

All sample containers will be stored in an insulated cooler containing ice immediately after collection to maintain the samples at a temperature of approximately 4^{o} Celsius until delivery

to the laboratory. Sample containers from each station will be grouped and placed in plastic bags to facilitate sample receipt and login. At the end of each sampling day, all samples will be transported back to the King County Environmental Laboratory.

6.7 Chain of Custody

Chain of custody (COC) will commence at the time that each sample is collected. While in the field, all samples will be under direct possession and control of King County field staff. For chain of custody purposes, the *Liberty* will be considered a "controlled area." Each day, all sample information will be recorded on a COC form (Figure 2). This form will be completed in the field and will accompany all samples during transport and delivery to the laboratory each day. Upon arrival at the King County Environmental Laboratory, the sample delivery person will relinquish all samples to the sample login person. The date and time of sample delivery will be recorded and both parties will then sign off in the appropriate sections on the COC form at this time. Once completed, original COC forms will be archived in the project file.

Samples delivered after regular business hours will be stored in a locked chain of custody refrigerator until the next day. Samples delivered to a contracted laboratory will be accompanied by a properly-completed King County Environmental Laboratory COC form and custody seals will be placed on the cooler if samples are delivered by an outside courier. Contracted laboratories will be expected to provide a copy of the completed COC form as part of their analytical data package.

7 SAMPLE DOCUMENTATION

Sampling information and sample metadata will be documented using the methods noted below.

- Field sheets generated by King County's Laboratory Information Management System (LIMS) that will include information such as:
  1. sample ID number
  2. station name
  3. station bottom depth
  4. sediment depth (i.e., sampler penetration depth) for each successful deployment
  5. sediment depth stratum sampled (0- to 2-cm)
  6. physical sediment characteristics
  7. date and time of sample collection
  8. condition and height of tide
  9. initials of all sampling personnel
- LIMS-generated container labels will identify each container with a unique sample number, station and site names, collect date, analyses required, and preservation method.
- The *Liberty's* logbook will contain records of all shipboard activities, destinations, arrival and departure times, general weather and positioning information, and the names of shipboard personnel.
- The *Liberty's* cruise plan will list the prescribed stations to be sampled, along with their respective coordinates and other associated locating information.
- Electronic DGPS coordinate data will be electronically logged for each acceptable grab sample using both latitude/longitude and NAD 83 State Plane formats.
- COC documentation will consist of the Lab's standard COC form, which is used to track release and receipt of each sample from collection to arrival at the lab.

A sample of a typical field sheet used by the King County Environmental Laboratory is included as Figure 3.

8 FIELD MEASUREMENTS AND OBSERVATIONS

The following field measurements and observations will be recorded on the appropriate field sheet/log for each sample:

- sample (bottom) depth - measured as keel depth by vessel's fathometer;
- sediment depth (grab penetration depth) - measured by ruler inside the grab;
- sediment sampling range (0 to 10 cm);
- sediment type (a mnemonic code indicating color, gross grain size, odor, and debris);
- tide condition and height; and
- collect date, start time, and sampling personnel.

9 ANALYTICAL PARAMETERS AND METHODS

Analytical parameters for sediment chemistry samples are presented in the following sections. All analyses will follow guidelines suggested in the Puget Sound Protocols (PSEP 1986, 1997b, and 1997c) and will be performed at the King County Environmental Laboratory. Sample containers for butyltin analysis will be stored frozen and held until October, at which time the samples will be batched and analyzed with sediment samples from another project for increased efficiency.

The terms MDL and RDL, used in the following chemistry analysis sections, refer to *method detection limit* and *reporting detection limit*, respectively. The MDL is defined as *the minimum concentration of a chemical constituent that can be detected*, while the RDL is defined as *the minimum concentration of a chemical constituent that can be reliably quantified.*

9.1 Conventionals – Analytical Methods and Detection Limits

Conventional sediment parameters will include ammonia, PSD, TOC, total solids, and total sulfides. The analytical methods and detection limits for conventional parameters are summarized in Table 9-1.

Table 9-1
Conventionals Methods and Detection Limits

Parameter	Method	MDL	RDL	Units
Parameter	**Method**	**MDL**	**RDL**	**Units**
Ammonia	SM 4500-NH3-G	0.1	0.2	mg/Kg wet wt.
PSD (gravel and sand)	ASTM D422	0.1	1.0	percent dry wt.
PSD (silt and clay)	ASTM D422	0.5	1.0	percent dry wt.
Total Organic Carbon	EPA 9060, PSEP 1996	500	1,000	mg/Kg wet wt.
Total Solids	SM 2540-G	0.005	0.01	percent wet wt.
Total Sulfide	EPA 9030B/SM4500-S2-D	0.5	2.0	Mg/Kg wet wt.

Total solids will be analyzed on all samples to allow normalization of all other sediment chemistry data to dry weight. Total solids analysis will be performed according to the latest edition of Standard Method (SM)2540-G (APHA 1998), which is a gravimetric determination.

TOC analysis will be performed on all samples to allow normalization of some organic parameters to organic carbon. TOC analysis will be performed according to EPA Method 9060/SW-846 (EPA 1995), high-temperature combustion with infrared spectroscopy.

PSD analysis will be performed according to ASTM Method D422 (ASTM 2002), which is a combination of sieve and hydrometer analyses. Results for PSD analysis are presented both for phi sizes and for the four broad classifications of clay, silt, sand, and gravel. Results for the clay and silt fractions are also summed to provide a result for "percent fines."

Ammonia and total sulfide, which are indicators of potential sediment toxicity, will be analyzed by SM 4500-NH3-G and SM 4500-S2-D (EPA 9030B), respectively. Ammonia analysis will involve a potassium chloride extraction followed by spectrometric analysis of the extract. Total sulfide will be analyzed by distillation following acidification and colorimetric analysis of the distillate.

9.2 Metals – Analytical Methods and Detection Limits

Detection limits for the 13 target trace metals are summarized in Table 9-2. These MDLs and RDLs are presented on a wet-weight basis and are based on an initial analytical sample weight of 1 (+/- 0.05) gram (g) and a final volume of 50 milliliters (ml) for ICP metals and 100 ml for mercury. Sample weights will be increased if the total solids are low enough that, when dry-weight normalized, the sample-specific RDL will not meet SMS chemical criteria. Mercury will be analyzed by cold vapor atomic absorption spectroscopy (CVAA), following EPA Method 7471B (SW-846) and other metals will be analyzed by inductively coupled plasma optical emission spectroscopy (ICP-OES) with a strong acid digestion, following EPA Methods 3050B/6010C (SW8-846).

Table 9-2
Metals Target Analytes, Methods, and Detection Limits (mg/Kg wet weight)

Analyte	MDL	RDL
Aluminum	5	25
Antimony	0.75	3.75
Arsenic	1.25	6.25
Cadmium	0.10	0.50
Chromium	0.15	0.75
Copper	0.20	1.0
Iron	2.5	12.5
Lead	1.0	5.0
Mercury	0.005	0.05
Nickel	0.25	1.25
Silver	0.20	1.0
Tin	1.0	5.0
Zinc	0.25	1.25

Appendix A presents the SMS criteria that must be met by sample-specific RDL values after normalization to dry weight.

9.3 Trace Organics – Analytical Methods and Detection Limits

Trace organic parameters will include the BNAs, total 4-nonylphenol, chlorinated pesticides, PCBs, butyltins, and PBDEs. The analytical methods and detection limits for the target analytes are summarized in Tables 9-3 through 9-7 and shown on a wet-weight basis.

Results for certain non-ionizing organic compounds are normalized to organic carbon for comparison to SMS chemical criteria when the dry-weight TOC values are between 5,000 and 50,000 mg/Kg (0.5 to 5%). If the dry-weight TOC values are below 5,000 mg/Kg, results for the same non-ionizing organic compounds are dry-weight normalized before comparison to the 1988 Marine Dry Weight criteria found on Ecology's MyEIM website. Ionizing organic compounds are always dry-weight normalized before comparison to their SQS criteria.

The King County Environmental Laboratory has attempted to optimize its procedures to produce the lowest cost-effective RDLs that are routinely achievable in a standard sediment sample. These RDLs should meet the required SQS chemical criteria for each parameter in most cases. The ability of the laboratory to attain detection limits which meet organic-carbon normalized chemical criteria, however, will depend upon the TOC content of each sample.

9.3.1 BNA Target Analytes and Detection Limits

The wet-weight detection limits for the target BNA compounds are summarized in Table 9-3. These MDLs and RDLs are based on a 30 g extraction with gel permeation cleanup and concentration to a final volume of 1.0 ml for analysis. Note that the detection limits can vary if limited sample is available for extraction (less than 30 g) or if dilution is required due to elevated analyte concentration(s). BNA analysis will be performed according to EPA methods 3550B/8270D (SW 846), which employ a solvent extraction with sonication and analysis by gas chromatography/mass spectroscopy (GC/MS).

Table 9-3
BNA Target Analytes and Detection Limits (μg/Kg wet weight)

Analyte	MDL	RDL	Analyte	MDL	RDL
1,2,4-Trichlorobenzene	0.53	1.07	Dibenzo(a,h)anthracene	5.3	10.7
1,2-Dichlorobenzene	8.8	8.80	Dibenzofuran	5.3	10.7
1,4-Dichlorobenzene	8.0	8.00	Diethyl phthalate	11	21.3
2,4-Dimethylphenol	5.3	10.7	Dimethyl phthalate	11	21.3
2-Methylnaphthalene	5.3	10.7	Di-n-butyl phthalate	11	21.3
2-Methylphenol	5.3	10.7	Di-n-octyl phthalate	11	21.3
3-,4-Methylphenol	27	53.3	Fluoranthene	5.3	10.7
Acenaphthene	5.3	10.7	Fluorene	5.3	10.7
Acenaphthylene	5.3	10.7	Hexachlorobenzene	0.53	1.07
Anthracene	5.3	10.7	Hexachlorobutadiene	2.7	5.33
Benzo(a)anthracene	5.3	10.7	Indeno(1,2,3-cd)pyrene	5.3	10.7
Benzo(a)pyrene	5.3	10.7	Naphthalene	5.3	10.7
Benzo(b,j,k)fluoranthene	5.3	10.7	N-Nitrosodiphenylamine	13	13.3
Benzo(g,h,i)perylene	5.3	10.7	Pentachlorophenol	80	80.0
Benzoic acid	110	107	Phenanthrene	5.3	10.7
Benzyl alcohol	13	13.3	Phenol	27	80.0
Benzyl butyl phthalate	8.0	8.00	Pyrene	5.3	10.7
Bis(2-ethylhexyl) phthalate	11	21.3	Total 4-nonylphenol	53	107
Chrysene	5.3	10.7			

Prior to BNA preparation and analyses, the Total Solids and Total Organic Carbon results will be used to verify that the standard 30 g to 1 ml extraction will allow analyte RDLs to meet the appropriate SQS criteria (depending upon the compound and/or TOC value). Historical solids and organic carbon data may be used for this purpose if available and consistent over time. The extraction sample amount and final volumes will be adjusted accordingly to ensure that the RDL is at or below the appropriate SQS criteria.

The MDL and RDL for specific analytes requiring dilution (e.g., exceedence of analyte calibration range) will be increased to reflect the dilution. In cases where a dilution is necessitated by a matrix interference or other sample issue, and the resulting RDL for a specific analyte exceeds the SQS criteria but the analyte is not detected, the RDL exceedence of the SQS criteria will be discussed with the project manager and noted in the appropriate analytical case narrative.

Appendix A presents the SQS criteria that must be met after appropriate normalization to either organic carbon or dry weight.

9.3.2 Chlorinated Pesticide and PCB Target Analytes and Detection Limits

The detection limits for the target chlorinated pesticides and PCB Aroclors® are summarized in Tables 9-4 and 9-5. These MDLs and RDLs are presented on a wet-weight basis and are based on combined extraction (chlorinated pesticides, PCBs, and PBDEs) of a 20 g sample, gel permeation cleanup, and concentration to a final volume of 2.5 ml for pesticides and 0.5 ml for PCBs/PBDEs (same extract).

When reporting PCB results, the King County Environmental Laboratory will report each individual Aroclor result and calculate Total Aroclors as the sum of detected Aroclors. If no individual Aroclors are detected in a sample, the reported MDL/RDL for the Total Aroclors parameter will be set equal to the highest MDL/RDL among the individual Aroclors reported for the sample.

Note that the detection limits can vary if limited sample is available for extraction (less than 20 g) or if dilution is required due to elevated analyte concentration(s). Chlorinated pesticide/PCB analysis will be performed according to EPA methods 3550B/8081B/8082A (SW 846), which employ solvent extraction with sonication and analysis by gas chromatography with electron capture detector (GC/ECD) and dual column confirmation.

Table 9-4

Chlorinated Pesticide Target Analytes and Detection Limits (µg/Kg wet weight)

Analyte	MDL	RDL	Analyte	MDL	RDL
4,4'-DDD	1.0	2.0	Endosulfan II	1.0	2.0
4,4'-DDE	1.0	2.0	Endosulfan Sulfate	1.0	2.0
4,4'-DDT	1.0	2.0	Endrin	1.0	2.0
Aldrin	1.0	2.0	Endrin Aldehyde	1.0	2.0
Alpha-BHC	0.50	1.0	Gamma-BHC (Lindane)	0.50	1.0
Alpha-Chlordane	0.50	1.0	Gamma-Chlordane	0.50	1.0
Beta-BHC	0.50	1.0	Heptachlor	0.50	1.0
Delta-BHC	0.50	1.0	Heptachlor Epoxide	0.50	1.0
Dieldrin	1.0	2.0	Methoxychlor	5.0	10
Endosulfan I	1.0	2.0	Toxaphene	10	20

Table 9-5

PCB Target Analytes and Detection Limits (µg/Kg wet weight)

Analyte	MDL	RDL	Analyte	MDL	RDL
Aroclor 1016	1.3	2.5	Aroclor 1248	1.3	2.5
Aroclor 1221	2.5	5.0	Aroclor 1254	1.3	2.5
Aroclor 1232	2.5	5.0	Aroclor 1260	1.3	2.5
Aroclor 1242	1.3	2.5	Total Aroclors *	1.3	2.5

*When Aroclors are detected, the reported MDL/RDL for the Total Aroclors parameter will be lowest MDL/RDL of the individual Aroclors.

9.3.3 Butyltin Target Analytes and Detection Limits

The wet-weight detection limits for target butyltin isomers are summarized in Table 9-6. These MDLs and RDLs are based on a 20 g extraction with derivatization and silica gel/alumina cleanup and concentration to a final volume of 5 ml for analysis. Note that the detection limits can vary if limited sample is available for extraction (less than 20 g) or if dilution is required due to elevated analyte concentration(s). Butyltin analysis will be performed according to a National Oceanic and Atmospheric Administration method (Krone

et al. 1989) which employs a methylene chloride extraction with tumbling, followed by derivatization through a Gringnard reaction, and analysis by GC/ICPMS.

Table 9-6
Butyltin Isomer Target Analytes and Detection Limits (μg/Kg wet weight)

Analyte	MDL	RDL	Analyte	MDL	RDL
Mono-n-butyltin	17	33.7	Tri-n-butyltin	2.1	4.15
Di-n-butyltin	3.5	7.0	Tetra-n-butyltin	4.0	8.01

9.3.4 PBDE Target Analytes and Detection Limits

The wet-weight detection limits for target PBDE congeners are summarized in Table 9-7. These MDLs and RDLs are based on a 20 g extraction with GPC cleanup and concentration to a final volume of 0.5 ml for analysis (combination extraction with chlorinated pesticides and PCBs). Note that the detection limits can vary if limited sample is available for extraction (less than 20 g) or if dilution is required due to elevated analyze concentration(s). PDBE analysis will be performed according to EPA method 3550B (SW-846) and King County standard operating procedure (SOP) #755, employing solvent extraction with sonication and analysis by GC-ICPMS.

Table 9-7
PBDE Target Analytes and Detection Limits (μg/Kg wet weight)

Analyte	MDL	RDL	Analyte	MDL	RDL
PBDE-17	0.010	0.020	PBDE-100	0.010	0.020
PBDE-28	0.010	0.020	PBDE-138	0.010	0.020
PBDE-47	0.010	0.020	PBDE-153	0.010	0.020
PBDE-66	0.010	0.020	PBDE-154	0.010	0.020
PBDE-71	0.010	0.020	PBDE-183	0.010	0.020
PBDE-85	0.010	0.020	PBDE-190	0.010	0.020
PBDE-99	0.010	0.020	PBDE-209	0.050	0.100

10 LABORATORY QA/QC

The quality control (QC) samples that will be analyzed in association with sediment chemistry samples are summarized in Table 10-1. The frequency of method blanks, duplicates, triplicates, and matrix spikes is one per QC batch (20 samples maximum). The frequency of SRM (standard reference material) or LCS (laboratory control sample) analysis is one per project (40 samples maximum). LCS analysis is used in lieu of SRM analysis for selected analytes when an SRM may not be readily available. Surrogates are analyzed with every organic sample.

Table 10-1
Marine Sediment Chemistry Quality Control Samples

Analyte	Method Blank	Spiked Blank	Duplicate/ Triplicate	Matrix Spike (MS)	MS Duplicate	SRM/LCS	Surrogates
Ammonia	Yes	Yes	Triplicate	Yes	No	Yes	No
PSD	No	No	Triplicate	No	No	No	No
TOC	Yes	Yes	Triplicate	Yes	No	Yes	No
Total Solids	Yes	No	Triplicate	No	No	No	No
Total Sulfide	Yes	Yes	Triplicate	Yes	No	No	No
Mercury	Yes	Yes	Duplicate	Yes	Yes	Yes	No
Other Metals	Yes	Yes	Duplicate	Yes	No	Yes	No
BNAs	Yes	Yes	Duplicate	Yes	Yes	Yes	Yes
Butyltins	Yes	Yes	Duplicate	Yes	Yes	Yes	Yes
Chl. Pesticides	Yes	Yes	Duplicate	Yes	Yes	Yes	Yes
PCBs	Yes	Yes	Duplicate	Yes	Yes	Yes	Yes
PBDEs	Yes	Yes	Duplicate	Yes	Yes	No	Yes
Nonylphenol	Yes	Yes	Duplicate	Yes	Yes	No	Yes

Quality assurance (QA1) marine sediment chemistry acceptance criteria (Ecology 1989) are shown in Table 10-2.

Table 10-2
QA1 Acceptance Criteria for Marine Sediment Chemistry Samples

Analyte	Method Blank	Spiked Blank	Duplicate/ Triplicate	Matrix Spike	SRM/LCS	Surrogates
Ammonia	< MDL	80 – 120%	RSD ≤ 20%	75 - 125%	80 – 120%	N/A
PSD	N/A	N/A	RSD ≤ 20%	N/A	N/A	N/A
TOC	< MDL	80 - 120%	RSD ≤ 20%	75 - 125%	80 - 120%	N/A
Total Solids	< MDL	N/A	RSD ≤ 20%	N/A	N/A	N/A
Total Sulfide	< MDL	80 - 120%	RSD ≤ 20%	65 - 135%	N/A	N/A
Metals (incl. Hg)	< MDL	85 – 115%	RPD ≤ 20%	75 - 125%	Appendix B	N/A
BNAs	< MDL	Appendix B	RPD ≤ 35%	Appendix B	Appendix B	Appendix B
Butyltins	< MDL	Appendix B	RPD ≤ 35%	Appendix B	Appendix B	Appendix B
Chl. Pesticides	< MDL	Appendix B	RPD ≤ 35%	Appendix B	Appendix B	Appendix B
PCBs	< MDL	Appendix B	RPD ≤ 35%	Appendix B	Appendix B	Appendix B
PBDEs	< MDL	Appendix B	RPD ≤ 35%	Appendix B	Appendix B	Appendix B
Nonylphenol	<MDL	Appendix B	RPD ≤ 35%	Appendix B	N/A	Appendix B

< MDL - Method Blank result should be less than the *method detection limit*.
RPD – Relative Percent Difference, RSD – Relative Standard Deviation
QC results for matrix spike, SRM/LCS, and surrogates are in *percent recovery of analyte*.

Some trace metal and organic analyses have empirically-derived acceptance limits for various QC samples. These are laboratory-derived, performance-based control limits that may be updated one per calendar year. The limits in effect at the time of analysis will be used as accuracy limits for the spike blank, matrix spike and matrix spike duplicate, laboratory control sample, and ongoing precision and accuracy samples. Current laboratory-derived acceptance limits for trace metal and trace organic analyses are included as Appendix B (Tables B1 – B14).

QC results that exceed the acceptance limits will be evaluated to determine appropriate corrective actions. Samples will typically be reanalyzed if the unacceptable QC results indicate a systematic problem with the overall analysis. Unacceptable QC results caused by a particular sample or matrix will not require reanalysis unless an allowed method modification would improve the results. Analytical results that do not meet QA1 acceptance criteria will be qualified and flagged according to Ecology guidance (Ecology 2008).

11 DATA REPORTING AND RECORD KEEPING

This section provides information on how monitoring data will be reported and interpreted and how project records will be maintained.

11.1 Analytical Data

All sediment chemistry data will be reported in QA1 format (Ecology 1989). The final QA1 report will contain the following information and deliverables:

- a QA1 narrative discussing data quality in relation to study objectives and data criteria;
- all associated QC data (LIMS QC reports and worklists);
- copies of field sheets and COC forms; and
- a comprehensive report containing all analytical and field data (including data qualifier flags).

11.2 Final Report and EIMS Files

A final monitoring report will be prepared that will include a presentation and interpretation of the sediment chemistry results. The report will compare sediment chemistry results to published sediment quality chemical criteria (Ecology 1995, EPA1988) as well as regional Puget Sound values in order to provide an evaluation of sediment quality in Elliott Bay. The chemistry data will be also reported in the regional Environmental Information Management System (EIMS) format for delivery to Ecology.

11.3 Record Keeping

All field and sampling records, custody documents, raw lab data, and summaries and narratives will be archived according to King County Environmental Laboratory policy, for a minimum of 10 years from the date samples were collected. Interpretive reports and memoranda, along with all chemistry data, data analysis project narratives, and reports will be stored in project files for a minimum of 10 years from the date samples were collected. Appendix C includes LIMS “product names” and “list types” under which analytical data will be stored.

12 PROJECT HEALTH AND SAFETY

The following general health and safety guidelines have been provided in lieu of a site-specific Health and Safety Plan. These guidelines will be read and understood by all members of the sampling crew.

- All crew of the research vessel will follow all aspects of the King County Environmental Laboratory Vessel Safety Plan.
- Samplers will wear chemical-resistant gloves when coming into contact with sediment.
- No eating or drinking by sampling personnel will be allowed during active sampling operations.
- All sampling operations will be conducted during daylight hours.
- All accidents, 'near misses,' and symptoms of possible exposure will be reported to a crew member's supervisor within 24 hours of occurrence.
- All crew members will be aware of the potential hazards associated with any chemicals used during the sampling effort.

Several hazards are inherent to marine sediment sampling. General vessel safety, physical hazards unique to sediment grab sampling, and chemical hazards are discussed in sections 12.1 through 12.3.

12.1 General Vessel Safety

To help prevent accidents and ensure adequate preparation for emergencies that may possibly arise, the following safety equipment will be required on the *Liberty*:

- one personal floatation device (PFD) for each crew member and one throwable PFD;
- an accessible, clearly labeled, fully stocked first-aid/CPR kit;
- an accessible and clearly-labeled eye wash (when sampling suspected contaminated sediments);
- one (preferably two) VHF marine radio(s) with weather channel;
- a cellular telephone;
- a horn;
- navigation lights;
- an emergency life raft;
- an anchor and suitable line;
- signal flares; and
- a reach pole or shepherd's hook.

Personal protective equipment will be selected and used that will protect workers involved in sediment sampling from the hazards and potential hazards likely to be encountered. Minimum required personal protective equipment for marine sediment sampling shall include the following:

- hard hat;
- steel-toe rubber boots;
- chemical-resistant gloves (e.g. Nitrile); and
- safety glasses.

Recommended additional personal protective equipment will include rain gear and hearing protection when the *Liberty* is under way.

12.2 Grab Sampling

Sampler deployment and sediment retrieval present physical hazards due, in part, to the heavy weight of the grab sampler, its suspension above the vessel deck, and the risk of accidental or premature closure. Prior to each sampling event, all cabling, shackles, pins, housings, and swivels will be inspected to ensure the integrity of all points along the sampling assembly.

The sampler will always be set while it is resting on a stable surface. Once set, a safety pin will be set in place on the triggering mechanism and remain in place until the sampler is swung outboard of the vessel rail. Special care will be exercised when removing the safety pin to ensure personal safety in the event of a gear or winch failure. Fingers will not be placed through the ring of the pin when it is removed and hands will be kept completely clear of the sampler interior after the pin has been removed. If a sampler is retrieved that has not been tripped, it will be lowered to a stable surface before any worker contact.
During grab retrieval, one crew member will watch for the appearance of the grab sampler and alert the winch operator when the sampler is first visible below the water surface. Attempting to bring a swinging grab sampler on board poses a serious risk of being hit or knocked overboard. The winch operator will minimize swinging before the grab sampler is brought on board for the crew to secure. Hard hats and gloves will always be worn when handling the grab sampler.

The winch drum, blocks, capstan, and any area between the grab sampler and railings, the deck, and heavy equipment all represent significant pinching and crushing hazards. Only experienced crew members will operate the winch or capstan during a sampling event. Other crew members will exercise care to avoid these potentially hazardous areas.

12.3 Chemical Hazards

Contact with marine sediment at some sampling stations may present a health hazard from chemical constituents of the sediment, such as PCBs, mercury, phthalates, and PAHs. Potential routes of exposure to chemical hazards include **inhalation, skin and eye absorption, ingestion, and injection**. Crew members will exercise caution to avoid coming into contact with sediment at all stations during sampling operations. Protective equipment will include chemical-resistant gloves, safety glasses or goggles, and protective clothing (e.g. rain gear). Crew members will exercise good personal hygiene after sampling and prior to eating or drinking.

13 REFERENCES

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FIGURES

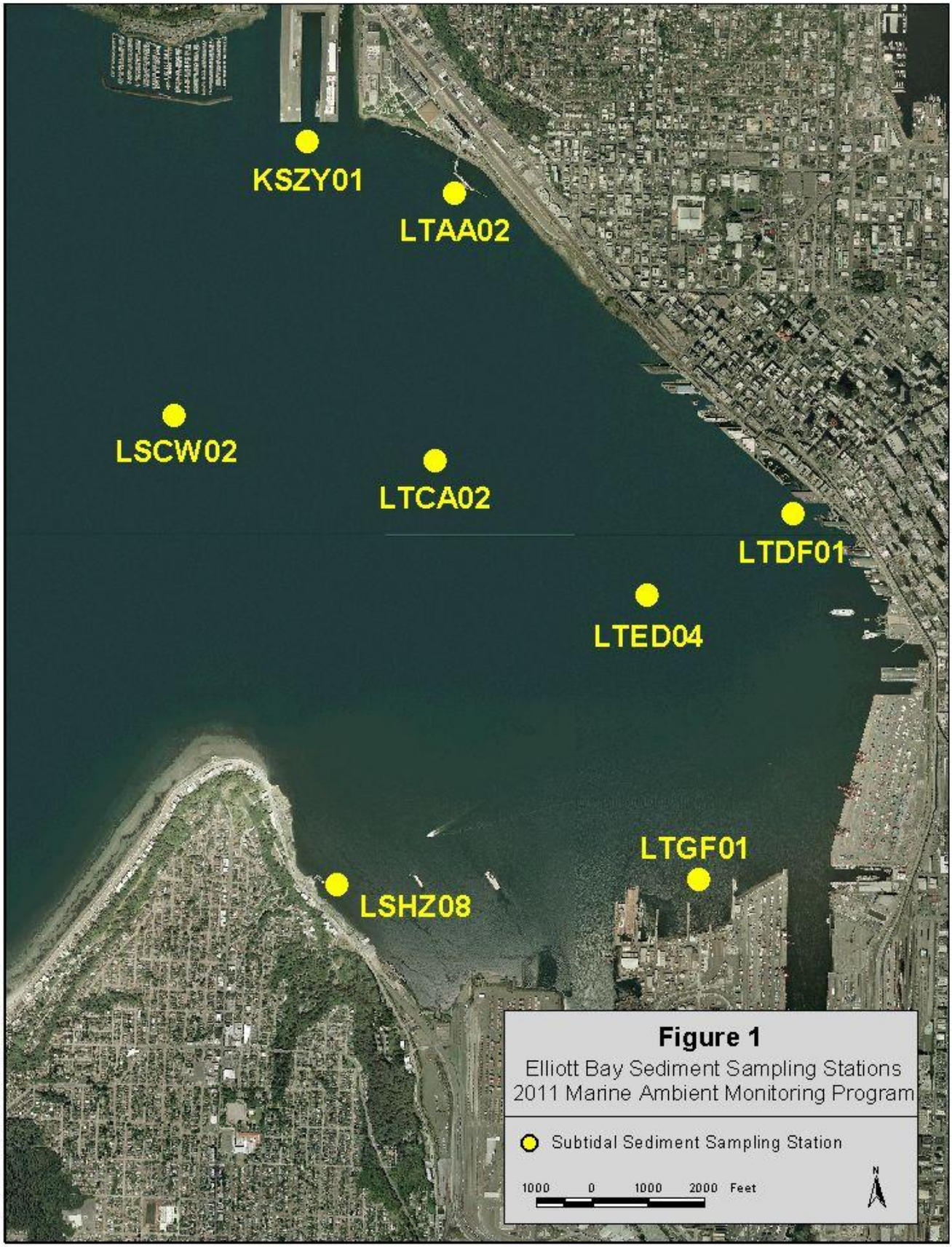
KSZY01
LTAA02
LSCW02
LTCA02
LTDF01
LTED04
LTGF01
LSHZ08
Figure 1
Elliott Bay Sediment Sampling Stations
2011 Marine Ambient Monitoring Program
Subtidal Sediment Sampling Station
1000 0 1000 2000 Feet
N

FIGURE 2

King County Environmental Laboratory
Chain of Custody Form

LABORATORY WORK ORDER
Chain of Custody

King County Department of Natural Resources
Water and Land Resources Division
Environmental Laboratory
322 West Ewing Street
Seattle, Washington 98119-1507

Project Name:
Project Number:
Laboratory Project Manager:
Telephone Number:

				Analyses															
Sample Number	Locator	Collect Date	Collect Time	BNAS	BUTYLTIN	CHLOROBENZENES	METHYL MERCURY	PCBS	METALS - ICP	MERCURY - CVAA	AMMONIA	OIL & GREASE	PSD	TOC	SOLIDS	SULFIDE		Number of Containers	Comments

Additional Comments:

Total Number of Containers

Sampled By:

Relinquished By:		Received By:	
Signature	Date	Signature	Date
Printed Name	Time	Printed Name	Time
Organization		Organization King County Environmental Laboratory	

FIGURE 3

King County Environmental Laboratory
Standard Field Sheet

Fieldsheet ID: 421235_22JUN1999_101133 Page: 1

MAJOR LAKES (wtr col)

Project Number: 421235 Personnel: _____

Sample Number	P15790-1	P15790-2	P15790-3
Locator	0618	0623	0625
Short Loc. Desc.		Rosemnt SD	Sammslough
Locator Desc.		LAKE SAMM/WEST SHORE-ROSEMONT STOR	Lake Sammamish
Site	MAJOR LAKES	MAJOR LAKES	MAJOR LAKES
Sample Depth			
Collect Date			
Comments			
EH, FIELD			
SED DEPTH			
SED SAMP RANGE			
SED TYPE			
TIME			
Dept., Matrix, Prod			
	3 FRSHWTRSED AVS	3 FRSHWTRSED AVS	3 FRSHWTRSED AVS
	3 FRSHWTRSED NH3	3 FRSHWTRSED NH3	3 FRSHWTRSED NH3
	3 FRSHWTRSED PSD	3 FRSHWTRSED PSD	3 FRSHWTRSED PSD
	3 FRSHWTRSED TOC	3 FRSHWTRSED TOC	3 FRSHWTRSED TOC
	3 FRSHWTRSED TOTP	3 FRSHWTRSED TOTP	3 FRSHWTRSED TOTP
	3 FRSHWTRSED TOTS	3 FRSHWTRSED TOTS	3 FRSHWTRSED TOTS
	3 FRSHWTRSED TOTSULFIDE	3 FRSHWTRSED TOTSULFIDE	3 FRSHWTRSED TOTSULFIDE
	6 FRSHWTRSED HG-CVAA	6 FRSHWTRSED HG-CVAA	6 FRSHWTRSED HG-CVAA
	6 FRSHWTRSED PP ICPMS	6 FRSHWTRSED PP ICPMS	6 FRSHWTRSED PP ICPMS
	7 FRSHWTRSED BNA	7 FRSHWTRSED BNA	7 FRSHWTRSED BNA
	7 FRSHWTRSED CHLOROBENZENES	7 FRSHWTRSED CHLOROBENZENES	7 FRSHWTRSED CHLOROBENZENES
	7 FRSHWTRSED CLPESTPCB	7 FRSHWTRSED CLPESTPCB	7 FRSHWTRSED CLPESTPCB
	7 FRSHWTRSED HERB	7 FRSHWTRSED HERB	7 FRSHWTRSED HERB
	7 FRSHWTRSED OPPEST	7 FRSHWTRSED OPPEST	7 FRSHWTRSED OPPEST
	7 FRSHWTRSED TRIBUTYLTIN	7 FRSHWTRSED TRIBUTYLTIN	7 FRSHWTRSED TRIBUTYLTIN
	7 FRSHWTRSED WTPH-HCID	7 FRSHWTRSED WTPH-HCID	7 FRSHWTRSED WTPH-HCID

End of Fieldsheet.

APPENDIX A
Table A-1

Sediment Management Standards Chemical Criteria
for Trace Metals and Trace Organics
Sediment Quality Standards (SQS) from Chapter 173-204 WAC
and 1988 Marine Dry Weight SQS from MyEIM Database

Table A-1
Sediment Management Standards Chemical Criteria

Metals	SQS (mg/Kg DW)[1]	Ionizing Organics	SQS (µg/Kg DW)[1]
Arsenic	57	Benzoic Acid	650
Cadmium	5.1	Benzyl Alcohol	57
Chromium	260	Phenol	420
Copper	390	2-Methylphenol	63
Lead	450	4-Methylphenol	670
Mercury	0.41	2,4-Dimethylphenol	29
Silver	6.1	Pentachlorophenol	360
Zinc	410		

Non-Ionizing Organics	SQS (mg/Kg OC)[1]	SQS (µg/Kg DW)[2]
Acenaphthene	16	500
Acenaphthylene	66	1,300
Anthracene	220	960
Fluorene	23	540
2-Methylnaphthalene	38	670
Naphthalene	99	2,100
Phenanthrene	100	1,500
Total LPAHs	370	5,200
Benzo(a)anthracene	110	1,300
Benzo(a)pyrene	99	1,600
Benzo(b,j,k)fluoranthene	230	3,200
Benzo(g,h,i)perylene	31	670
Chrysene	110	1,400
Dibenzo(a,h)anthracene	12	230
Fluoranthene	160	1,700
Indeno(1,2,3-c,d)pyrene	34	600
Pyrene	1,000	2,600
Total HPAHs	960	12,000
1,2-Dichlorobenzene	2.3	35
1,4-Dichlorobenzene	3.1	110
1,2,4-Trichlorobenzene	0.81	31
Hexachlorobenzene	0.38	22
Bis(2-ethylhexyl) Phthalate	47	1,300
Butyl Benzyl Phthalate	4.9	63
Diethyl Phthalate	61	200
Dimethyl Phthalate	53	71
Di-n-butyl Phthalate	220	1400
Di-n-octyl Phthalate	58	6,200
Dibenzofuran	15	540
Hexachlorobutadiene	3.9	11
N-Nitrosodiphenylamine	11	28
Total PCBs	12	130

[1]Sediment Quality Standard (SQS) from Chapter 173-204 WAC (Ecology 1995).

[2]1988 Marine Dry Weight SQS from MyEIM ((http://www.ecy.wa.gov/eim/myEIM.htm).

APPENDIX B
Tables B-1 through B-14

Metals and Trace Organics Performance-Based QC Limits

Table B-1a
Laboratory QC Limits for Sediment Metals – SRM Recoveries (PACS-2)

Parameter	Lower Limit (%)	Upper Limit (%)
Chromium	30	70
Copper	78	118
Lead	74	114
Mercury	80	120
Zinc	73	113

Table B-1b
Laboratory QC Limits for Soil Metals – LCS Recoveries (ERA SOIL)

Parameter	Lower Limit (%)	Upper Limit (%)
Arsenic	80	120
Cadmium	80	120
Silver	66	134

Table B-2
Laboratory QC Limits for Sediment BNAs – Matrix Spike Recoveries

Parameter	Lower Limit (%)	Upper Limit (%)	Parameter	Lower Limit (%)	Upper Limit (%)
1,2,4-Trichlorobenzene	35	117	Di-N-Butyl Phthalate	34	146
1,2-Dichlorobenzene	25	74	Di-N-Octyl Phthalate	50	155
1,4-Dichlorobenzene	19	76	Dibenzo(a,h)anthracene	37	129
2,4-Dimethylphenol	5	115	Dibenzofuran	14	129
2-Methylnaphthalene	10	111	Diethyl Phthalate	26	142
2-Methylphenol	20	90	Dimethyl Phthalate	31	127
3-,4-Methylphenol	10	163	Fluoranthene	10	168
Acenaphthene	40	95	Fluorene	18	131
Acenaphthylene	41	112	Hexachlorobenzene	20	130
Anthracene	10	150	Hexachlorobutadiene	21	78
Benzo(a)anthracene	40	158	Indeno(1,2,3-Cd)Pyrene	35	123
Benzo(a)pyrene	32	143	N-Nitrosodiphenylamine	20	135
Benzo(b,j,k)fluoranthene	31	153	Naphthalene	15	107
Benzo(g,h,i)perylene	20	121	Pentachlorophenol	30	151
Benzoic Acid	5	130	Phenanthrene	10	146
Benzyl Alcohol	10	95	Phenol	30	105
Benzyl Butyl Phthalate	30	150	Pyrene	20	150
Bis(2-Ethylhexyl)Phthalate	30	160	Total 4-nonylphenol	29	161
Chrysene	41	127			

Table B-3
Laboratory QC Limits for Sediment BNAs – Blank Spike Recoveries

Parameter	Lower Limit (%)	Upper Limit (%)	Parameter	Lower Limit (%)	Upper Limit (%)
1,2,4-Trichlorobenzene	21	115	Di-N-Butyl Phthalate	50	150
1,2-Dichlorobenzene	21	118	Di-N-Octyl Phthalate	54	146
1,4-Dichlorobenzene	32	78	Dibenzo(a,h)anthracene	53	137
2,4-Dimethylphenol	5	80	Dibenzofuran	44	106
2-Methylnaphthalene	25	129	Diethyl Phthalate	40	138
2-Methylphenol	10	100	Dimethyl Phthalate	41	128
3-,4-Methylphenol	10	125	Fluoranthene	50	120
Acenaphthene	40	100	Fluorene	45	109
Acenaphthylene	48	111	Hexachlorobenzene	36	112
Anthracene	55	112	Hexachlorobutadiene	17	92
Benzo(a)anthracene	68	130	Indeno(1,2,3-Cd)Pyrene	54	127
Benzo(a)pyrene	62	113	N-Nitrosodiphenylamine	5	128
Benzo(b,j,k)fluoranthene	61	126	Naphthalene	29	100
Benzo(g,h,i)perylene	36	126	Pentachlorophenol	20	121
Benzoic Acid	10	150	Phenanthrene	58	106
Benzyl Alcohol	10	90	Phenol	17	92
Benzyl Butyl Phthalate	46	147	Pyrene	50	125
Bis(2-Ethylhexyl)Phthalate	49	129	Total 4-nonylphenol	28	107
Chrysene	59	110			

Table B-4
Laboratory QC Limits for Sediment BNAs – Surrogate Recoveries

Parameter	Lower Limit (%)	Upper Limit (%)
2,4,6-Tribromophenol	20	150
2-Fluorophenol	20	120
d5-Phenol	17	103
d5-Nitrobenzene	16	103
d4-2-Chlorophenol	13	101
d4-1,2-Dichlorobenzene	20	140
2-Fluorobiphenyl	22	135
d14-Terphenyl	45	150
d4-4-Nonylphenol	35	135

Table B-5
Laboratory QC Limits for Sediment BNAs – SRM Recoveries

Parameter	Lower Limit (%)	Upper Limit (%)
Anthracene	28	98
Benzo(a)anthracene	66	124
Benzo(a)pyrene	60	116
Benzo(b,j,k)fluoranthene	52	190
Benzo(g,h,i)perylene	15	121
Chrysene	77	136
Dibenzo(a,h)anthracene	10	200
Fluoranthene	45	126
Indeno(1,2,3-Cd)Pyrene	33	121
Naphthalene	10	29
Phenanthrene	51	106
Pyrene	36	135

Table B-6
Laboratory QC Limits for Sediment Pesticides and PCBs
Matrix Spike Recoveries

Parameter	Lower Limit (%)	Upper Limit (%)
4,4'-DDD	31	141
4,4'-DDE	30	145
4,4'-DDT	39	135
Aldrin	40	119
Alpha-BHC	37	134
Alpha-Chlordane	50	150
Beta-BHC	17	147
Delta-BHC	19	140
Dieldrin	40	130
Endosulfan I	45	153
Endosulfan II	40	160
Endosulfan Sulfate	26	144
Endrin	40	158
Endrin Aldehyde	31	140
Gamma-BHC (Lindane)	25	122
Gamma-Chlordane	50	150
Heptachlor	30	135
Heptachlor Epoxide	37	142
Methoxychlor	49	147
Aroclor 1016	45	139
Aroclor 1260	20	132

Table B-7
Laboratory QC Limits for Sediment Pesticides and PCBs
Blank Spike Recoveries

Parameter	Lower Limit (%)	Upper Limit (%)
4,4'-DDD	31	141
4,4'-DDE	30	145
4,4'-DDT	28	145
Aldrin	40	120
Alpha-BHC	37	134
Alpha-Chlordane	50	150
Beta-BHC	17	147
Delta-BHC	19	140
Dieldrin	32	144
Endosulfan I	45	153
Endosulfan II	40	160
Endosulfan Sulfate	26	144
Endrin	50	143
Endrin Aldehyde	31	140
Gamma-BHC (Lindane)	56	123
Gamma-Chlordane	50	150
Heptachlor	40	131
Heptachlor Epoxide	37	142
Methoxychlor	50	150
Aroclor 1016	36	117
Aroclor 1260	40	131

Table B-8
Laboratory QC Limits for Sediment Pesticides and PCBs
SRM and Surrogate Recoveries

Parameter	Lower Limit (%)	Upper Limit (%)
4,4'-DDT	10	200
Alpha-Chlordane	48	144
Aroclor 1254	57	139
Decachlorobiphenyl	25	150
2,4,5,6-Tetrachloro-m-xylene	20	110

Table B-9
Laboratory QC Limits for Sediment Butyltins
Matrix Spike Recoveries

Parameter	Lower Limit (%)	Upper Limit (%)
Tetra-n-butyltin (as tetrabutyltin)	50	150
Tri-n-butyltin (as tributyltin)	50	150
Di-n-butyltin (as dibutyltin)	40	160
Mono-n-butyltin (as monobutyltin)	40	160

Table B-10
Laboratory QC Limits for Sediment Butyltins
Blank Spike Recoveries

Parameter	Lower Limit (%)	Upper Limit (%)
Tetra-n-butyltin (as tetrabutyltin)	40	160
Tri-n-butyltin (as tributyltin)	40	160
Di-n-butyltin (as dibutyltin)	40	160
Mono-n-butyltin (as monobutyltin)	40	160

Table B-11
Laboratory QC Limits for Sediment Butyltins
SRM and Surrogate Recoveries

Parameter	Lower Limit (%)	Upper Limit (%)
Tri-n-butyltin (as tributyltin)	10	137
Di-n-butyltin (as dibutyltin)	18	183
Mono-n-butyltin (as monobutyltin)	17	165
Tripropyltin (surrogate)	24	100
Tripentyltin (surrogate)	35	100

Table B-12
Laboratory QC Limits for Sediment PBDEs
Blank Spike Recoveries

Parameter	Lower Limit (%)	Upper Limit (%)
TriBDE-17	42	122
TriBDE-28	30	136
TetraBDE-47	47	139
TetraBDE-66	50	155
TetraBDE-71	41	128
PentaBDE-85	40	128
PentaBDE-99	41	136
PentaBDE-100	38	122
HexaBDE-138	32	144
HexaBDE-153	39	130
HexaBDE-154	41	119
HeptaBDE-183	45	118
HeptaBDE-190	10	143
DecaBDE-209	10	108

Table B-13
Laboratory QC Limits for Sediment PBDEs
Matrix Spike Recoveries

Parameter	Lower Limit (%)	Upper Limit (%)
TriBDE-17	49	131
TriBDE-28	51	137
TetraBDE-47	48	140
TetraBDE-66	72	132
TetraBDE-71	53	130
PentaBDE-85	55	132
PentaBDE-99	51	131
PentaBDE-100	42	134
HexaBDE-138	40	161
HexaBDE-153	54	120
HexaBDE-154	44	134
HeptaBDE-183	52	125
HeptaBDE-190	40	129
DecaBDE-209	10	111

Table B-14
Laboratory QC Limits for Sediment PBDEs
SRM and Surrogate Recoveries

Parameter	Lower Limit (%)	Upper Limit (%)
TriBDE-17	60	200
TriBDE-28	48	153
TetraBDE-47	57	186
PentaBDE-85	40	176
PentaBDE-99	43	179
PentaBDE-100	53	148
HexaBDE-138	44	170
HexaBDE-153	37	168
HexaBDE-154	54	160
HeptaBDE-183	45	171
DecaBDE-209	90	200
Decachlorobiphenyl	42	134

APPENDIX C
Table C-1

Laboratory Information Management System (LIMS)
Products and List Types

Table C-1
King County Environmental Laboratory
Laboratory Information Management System (LIMS)
Products and List Types

Parameter	LIMS Product	LIMS List Type
Ammonia	NH3	CVNH3-KCL
PSD	PSD	CVPSD
TOC	TOC	CVTOC
Total Solids	TOTS	CVTOTS
Total Sulfide	TOTSULFIDE	CVTOTSULFIDE
Mercury by CVAA	HG-CVAA	MTHG-MIDS, 6-MIDS
Other Metals by ICP	AL-ICP, SB-ICP, AS-ICP, CD-ICP, CR-ICP, CU-ICP, FE-ICP, PB-ICP, NI-ICP, AG-ICP, SN-ICP, ZN-ICP	MTICP-SED, 6-SED
BNA SMS list (low-level)	BNASMS	ORBNASMS
Butyltins	TRIBUTYLTIN	ORBUTYLTIN
Chlorinated Pesticides (low-level)	PESTLL	ORPESTLL
PBDEs	PBDE	ORPBDE
PCBs (low-level)	PCBLL	ORPCBLL
Total 4-Nonylphenol	EDC	OREDC

CVAA – Cold vapor atomic absorption spectroscopy.
ICP – Inductively coupled plasma optic emission spectroscopy.